ORIGINAL ARTICLE

Patient self management of oral anticoagulation in routine care in the UK

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Background: Self management of anticoagulation: a randomised trial (SMART) was the first large scale UK trial to assess clinical and cost effectiveness of patient self management (PSM) of oral anticoagulation therapy compared to routine care. SMART showed that while PSM was as clinically effective as routine care, it was not as cost effective. SMART adds to the growing body of trial data to support PSM; however there are no data on clinical effectiveness and cost of PSM in routine care.
Aim: To evaluate clinical effectiveness of PSM compared to routine care outside trial conditions.
Methods: A retrospective multicentre matched control study. 63 PSM patients from primary care in the West Midlands were matched by age and international normalised ratio (INR) target with controls. INR results were collected for the period 1 July 2003–30 June 2004. The primary outcome measure was INR control.
Results: 38 PSM and 40 control patients were recruited. INR percentage time in range was 70% PSM vs 64% controls. 60% PSM were having a regular clinical review, 45% were performing an internal quality control (IQC) test and 82% were performing external quality assurance (EQA) on a regular basis.
Conclusion: PSM outside trial conditions is as clinically effective as routine UK care.

The move towards patient self management (PSM) of oral anticoagulation therapy has occurred due to an expansion of clinical indications for warfarin, development of reliable point of care (POC) testing devices for international normalised ratio (INR) estimation and patient demand for greater autonomy.[1–3] Patients undertaking self management are responsible for INR measurement using a POC system and adjusting their warfarin dose according to the result.

The clinical safety and effectiveness of PSM has recently been established in the UK with the Self Management of Anticoagulation Randomised Trial (SMART), which showed therapeutic control and an adverse event rate for PSM equivalent to that of routine UK care.[4] This trial also suggested that PSM is three times more expensive than standard care.[5]

In SMART, PSM patients were asked to perform an INR once every 2 weeks or more frequently if a dosage adjustment was required; in contrast the control group were monitored less frequently. The increased cost and equivalent therapeutic control of PSM shown in SMART may be due to increased frequency of testing dictated by the study protocol. There are no data on the level of therapeutic control and cost of PSM outside trial conditions where frequency of testing is driven by patient preference rather than trial protocol.

While guidelines outlining procedures for PSM include patient selection, training, clinical supervision and quality assurance have been published, they are based on evidence derived from self management within trial conditions due to a lack of clinical and health economic data for PSM outside trial conditions.[6] This article reports outcomes of the first UK based study to evaluate the clinical effectiveness and cost of PSM in routine care.

METHODS

The study was a retrospective multicentre matched control study. Eligible patients were identified from the SMART database; PSM patients had self managed their warfarin for 12 months and control patients had their warfarin managed in hospital or practice based anticoagulation clinics and continued to do so post-SMART trial. Each PSM patient was matched by age and INR target with at least one control. All patients were invited for an interview with a researcher, undertaken at their own primary care centre.

The primary outcome measure was therapeutic INR control determined by percentage time spent within therapeutic range calculated according to Rosendaal's equation, which assumes a linear change between INR results.[7] Secondary outcomes measures were cost, arrangements for PSM in accordance with clinical guidelines and INR control determined by point prevalence and number of tests in range.

Data collection

Twelve months' retrospective INR data in terms of test date, test result and warfarin dose for the period 1 July 2003 to 30 June 2004 were collected from patient hand held record books for all consenting patients. SMART trial INR data were collected from the SMART database for all consenting patients.

Data collection on the practicalities of PSM in routine care included arrangements for clinical supervision, frequency of clinical review, INR testing, internal quality control (IQC) and external quality assurance (EQA), method of EQA and information documented.

Cost data collection included the number and type of primary and secondary care contacts that were directly related to management of oral anticoagulation. Data on contacts were collected during the patient interview and confirmed in the primary care medical records. PSM patient cost data collection included cost of the POC device, quality control materials and other consumables used.

Analysis

The methodology allowed for two levels of analysis of therapeutic control: (i) PSM versus control post-SMART trial;

Abbreviations: EQA, external quality assurance; GP, general practitioner; INR, international normalised ratio; IQC, internal quality control; POC, point of care; PSM, patient self management

Table 1 Unit costs of routine care and patient self management

Variable	Cost (£)	Source
Patient self-management		
Machine	468.83	Roche
Test strip	2.50	Roche
Internal quality control test	5.00	Roche
Lancets (each)	0.03	BNF
Sharps bin	1.05	NHS diagnostics
Tissues (box of 150)	0.46	NHS diagnostics
Routine care	(cost per visit)	Study data
Hospital clinic	6.75	Study data
GP blood sample, hospital analysis and dosing	9.38	Study data
GP blood sample and dosing, hospital analysis	10.69	Study data
Practice POC clinic	14.16	Netten and Curtis, 2003
Staff costs (for cost of patient contacts and supervision)	29.00	Netten and Curtis, 2003
Practice nurse salary (per clinic hour)	116.00	Netten and Curtis, 2003
GP salary (per clinic hour)	83.00	Netten and Curtis, 2003
Community pharmacist	109.00	Whitley Council
Consultant	10.93	Netten and Curtis, 2003
Administration	15.00	Netten and Curtis, 2003
GP consultation	4.83	Netten and Curtis, 2003
Practice nurse phone call (10 min)	21.00	Netten and Curtis, 2003
GP telephone call (10.8 min)	13.83	Whitley Council
Community pharmacist phone call (10 min)	1.82	
Receptionist phone call (10 min)		

BNF, *British National Formulary*; NHS, National Health Service; GP, general practitioner; POC, point of care.
Netten and Curtis, 2003.[9]

and (ii) PSM within trial versus PSM post-trial. Sample size was limited by the number of patients who continued with PSM post-SMART trial. A paired t-test was used to ascertain differences between PSM SMART vs PSM post-trial and control SMART vs control post-trial. A two-sample t-test was used to determine if there were differences in the change in percentage time in therapeutic range PSM trial vs PSM post-trial compared with that of the control. Conditional logistic regression was used to determine if there were significant differences in point prevalence and percentage number of tests in range between trial periods (SMART vs post-trial) for each treatment arm. Logistic regression coefficients were compared to determine if changes observed in PSM and control groups between trial periods were significantly different between the two treatment arms. Equivalent non-parametric tests were performed to confirm the analysis.

Data collection was undertaken on all study patients in order that a patient level cost analysis could be conducted to compare costs of control and PSM groups. Anticoagulation costs incorporated costs directly related to anticoagulation management. The cost data were skewed and so the arithmetic mean was used along with its non-parametric 95% confidence interval.[8] Total NHS cost comprised of anticoagulation cost, including the cost of PSM patient reviews and quality control and health service contact related to warfarin management.

All unit costs were valued at 2003 prices in UK £ sterling in order for a direct comparison with costs from the original trial to be made.[9] (At current rates (2007) £1 is equivalent to €1.5 or $2.) Capital (equipment) costs were based on purchase prices and amortised over a 3, 5 or 10-year period (where appropriate) using a 3.5% discount rate.[10] Straight-line depreciation, and no residual value, was assumed. Table 1 presents unit costs. Base-case POC device lifetime was 10 years. Sensitivity analysis was undertaken to explore the effect on patient-level costs of changing the lifetime of the POC device to 3 and 5 years. In addition, indicative costs were calculated for a number of scenarios where the lifetime of the POC device and the average frequency of testing were varied. It was assumed that a patient had two reviews a year with their general practitioner (GP), carried out an IQC test every 3 months and an EQA test (primary care POC versus laboratory test) every 6 months.[6]

RESULTS

A total of 63/193 (33%) continuing to self manage post-SMART were identified and each was matched with at least one control. Of these, 45 (71%) PSM patients were found two matches. Therefore the names of 171 patients were sent to GPs to confirm eligibility (108 controls and 63 PSM patients). GPs excluded 10/63 (16%) PSM patients and 16/108 (15%) controls for reasons including deceased, housebound, left the practice or were too ill to participate. A total of 53/63 (84%) PSM patients were invited to participate. Of these, 3 (6%) PSM patients were no longer self-managing, 4 (7%) were not interested and 8 (15%) did not respond to the invitation.

A total of 92/108 (85%) controls were invited to participate. Of these, 47 (51%) self excluded, 3 (3%) were unable to attend

Table 2 Therapeutic control

	% time in range			Point prevalence			% No. test in range		
Group (n = 37)	Trial	Post-trial	p-Value	Trial	Post-trial	p-Value	Trial	Post-trial	p-Value
PSM	75	70*	0.12	78	70†	0.21	66	61‡	0.19
Control	64	57*	0.54	65	60†	0.48	57	54‡	0.25

PSM, patient self management.
p for comparison of change in trial and post-trial between the treatment arms; *p = 0.54, †p = 0.59, ‡p = 0.81.

Table 3 Arrangements for clinical supervision of PSM in routine care

Frequency of clinical follow-up	n (%)*
No arrangement/not seen	6 (16)
4 weeks	1 (2)
12 weeks	11 (29)
24 weeks	11 (29)
As and when required	9 (24)
Frequency of INR test	
Weekly	3 (8)
2 weeks	17 (45)
3 weeks	3 (8)
Monthly	15 (39)
Frequency of routine IQC	
None	21 (55)
12 weeks	11 (29)
More than 12 weeks	6 (16)
Reasons for performance of IQC	
Result above 5 or below 1.5	21 (55)
Unusual result	14 (37)
New box of strips	23 (60)
Other	2 (5)
Methods of EQA	
Patient POC vs clinic POC	16 (43)
Patient POC vs sample to lab	15 (39)
None	7 (18)
Frequency of EQA	
More than 12 weeks	18 (47)
12 weeks	13 (35)
None	7 (18)

PSM, patient self management; INR, international normalised ratio; IQC, internal quality control; EQA, external quality assurance; POC, point of care.
*n = 38.

the information session, 1 (1%) was housebound, and 1 was (1%) too unwell. A total of 21/92 (22%) did not respond and 17/92 (18%) were not interested.

Overall 78/145 (54%) consented to participate: 38/53 (72%) PSM patients and 40/92 (43%) controls; 37 were matched across the two groups by age and INR target.

Demographics

A total of 12/38 (34%) PSM patients and 13/40 (35%) controls were female. Mean age of PSM patients was 64 years and that of controls was 66 years. Eleven of 38 (29%) PSM patients had an INR target of 3.5 versus 11/40 (28%) controls; 27/38 (71%) PSM patients had an INR target of 2.5 versus 29/40 (72%) controls. A total of 42/78 (54%) had atrial fibrillation as the clinical indication for warfarin: 21/38 (55%) PSM patients versus 21/40 (53%) controls. Other indications were mechanical prosthetic valve, recurrent thrombosis, thrombosis, mitral/aortic valve disease, recurrent thrombosis on warfarin, transient ischaemic attack and cardiomyopathy.

Therapeutic INR control

There were no significant differences in mean percentage time spent within therapeutic range between the SMART trial and post-trial in the PSM arm (75% vs 70%, $p = 0.12$) or in the control arm (64% vs 57%, $p = 0.09$). No significant differences were found between the change in mean percentage time spent within the therapeutic range in the PSM trial and PSM post-trial compared with that in the control arm ($p = 0.54$) (table 2).

There were no significant differences in PSM point prevalence based on the last INR result recorded within each trial period (PSM trial 78% vs PSM post-trial 70%, $p = 0.21$). No significant difference in point prevalence was found between the control trial (65%) and control post-trial (60%) ($p = 0.48$). No significant differences were found between the change in PSM point prevalence trial versus post trial when compared with that of the control ($p = 0.59$) (table 2).

There were no significant differences in percentage number of tests in the range PSM trial (66% vs PSM post-trial 61%, $p = 0.19$) or control trial (57% vs control post-trial 54%, $p = 0.25$). No significant differences were found between the change in percentage number of tests in the range trial versus post-trial when compared across the treatment arms ($p = 0.81$) (table 2).

Level of adherence to clinical guidelines for PSM in routine care

A total of 23/38 (60%) patients were having a regular clinical review with their supervisor, 6/38 (16%) had no arrangements for review and 24% were reviewed when requested by the patient (table 3).

Frequency of testing and quality control procedures

The mean PSM frequency of testing for the trial period was 11 days (range 9–15) and post-trial 17 days (range 7–48). Mean control frequency of testing in the trial was 35 days (range 16–87) and post-trial 31 days (range 16–87). A total of 17/38 (45%) PSM patients reported two-weekly testing, 15/38 (39%) monthly, 3/38 (8%) three-weekly and 3/38 (8%) weekly (table 3).

A total of 11/38 (29%) performed IQC every 3 months and 16% at regular intervals other than three-monthly; 21/38 (55%) were not performing IQC (table 3). Two different methods of EQA were used: 16/38 (43%) compared INR on their POC device with a laboratory or practice POC device, and 15/38 (39%) compared INR from their POC device with a venous sample analysed by a local laboratory. Seven of 38 (18%) were not performing EQA. Overall 2/37 (5%) were not performing IQC or EQA procedures (table 3). All documented the INR result, test date and warfarin dose.

Cost analysis

The anticoagulation cost post-trial for PSM was £191.43 compared with £117.07 for controls. Results of the total NHS cost analysis show that post-trial PSM at £193.01 is more expensive than the control at £117.60 (table 4). When the lifetime of the POC device is shortened to 3 or 5 years the cost to the NHS for PSM is increased to £303.98 and £240.48

Table 4 Costs over 12 months by treatment group

	Mean (bootstrapped 95% CI)	
	Control arm (n = 40)	PSM arm (n = 38)
Anticoagulation cost (£)	117.07 (96.78 to 139.09)	191.43 (174.79 to 209.71)
Total NHS cost (£)	117.60 (95.22 to 139.97)	193.01 (175.44 to 210.71)

PSM, patient self management; NHS, National Health Service.

Table 5 Patient self management (PSM) sensitivity analysis and estimate of typical PSM costs

Analysis	Mean (bootstrapped 95% CI)
Base case anticoagulation cost	191.43 (174.79 to 209.71)
Anticoagulation cost with POC device over 3 years	302.40 (284.86 to 323.49)
Anticoagulation cost with POC device over 5 years	238.90 (220.99 to 256.97)
Base case total NHS cost	193.01 (175.44 to 210.71)
Total NHS cost with POC device over 3 years	303.98 (286.51 to 323.68)
Total NHS cost with POC device over 5 years	240.48 (224.15 to 260.52)
Indicative cost of anticoagulation with PSM	**Estimate (£)**
POC device over 10 years	
Weekly testing	263.30
Fortnightly testing	197.52
4-weekly testing	164.63
POC device over 5 years	
Weekly testing	310.77
Fortnightly testing	244.99
4-weekly testing	212.10
POC device over 3 years	
Weekly testing	374.27
Fortnightly testing	308.49
4-weekly testing	275.60

NHS, National Health Service; POC, point of care.

respectively (table 5). Different PSM scenarios considering POC device lifetime and frequency of testing were used to calculate indicative anticoagulation costs (table 5).

DISCUSSION

This was the first UK based study to evaluate the clinical effectiveness and cost of PSM of oral anticoagulation outside trial conditions compared to standard UK care. The study design allowed for comparison of therapeutic control of PSM in both within-trial and outside-trial conditions. Practicalities of PSM outside trial conditions were also explored.

The therapeutic control observed for PSM outside trial conditions compared favourably to that shown within the SMART trial with patients achieving around 70% of time within their therapeutic range.[4] There was a slight fall in post-trial PSM INR control compared with that in the trial; however this was not clinically significant and a similar change was observed in the control group. The results of the current study therefore suggest that PSM is safe and effective for a trained subgroup of the population, and levels of therapeutic control shown within trial conditions can be maintained outside trial conditions.[11]

Post-trial frequency of testing was driven by patient preference rather than being dictated by trial protocol. This study suggests that when given the choice the majority of patients will test less frequently than the two-weekly testing required by the SMART study protocol.

This study shows that PSM is more costly than standard UK care even outside trial conditions, with NHS costs per patient per year of around £193 compared with approximately £118 for routinely managed patients. The cost of anticoagulation per PSM patient per year compares more favourably with that of routinely managed patients (£165 vs £118) if the lifetime of the POC device is amortised over 10 years and INR is performed once every month. The extra cost however must be weighed up against the increased autonomy and control PSM offers patients and the reduction in workload it offers busy oral anticoagulation clinics. The cost of training outside trial conditions must also be taken into consideration when comparing cost effectiveness of PSM and routine care.

In accordance with current UK guidelines the majority of PSM patients retained contact with a named clinical supervisor, are having regular clinical review and are documenting data relevant to their warfarin management.[12]

A large proportion of patients were not performing a regular IQC and approximately 20% were not participating in an EQA scheme. The reasons for this may be associated with the cost to the patient of purchasing IQC materials and lack of supervisor familiarity with procedures for quality control and assurance. It is also possible that patients are reluctant to participate in EQA schemes due to previous experience of difficulties associated with comparison of results obtained from different techniques of INR measurement.[13] A UK national external quality assurance scheme (UK NEQAS) specifically for patients is now available.

The current study was limited by the number of patients continuing to self manage post-trial, with only 33% continuing to self manage. The principle reason for patient discontinuation was an inability to identify and access a clinical supervisor. Therefore the population in the current study may not be considered representative of the wider warfarinised population as (i) patients were selected (self and clinician selected) and (ii) patients had completed a strict training programme before embarking on trial self management.[11]

PSM outside trial conditions can be as clinically effective as standard UK care and cost compares favourably if INR control is maintained with less frequent testing. The majority of patients adhere to clinical guidelines, have a written agreement

Take-home messages

- Patient self management outside trial conditions can be as clinically effective as standard UK care for a trained subgroup of the population, and levels of therapeutic control shown within trial conditions can be maintained in routine care.
- The cost of patient self management (PSM) compares more favourably with standard UK care if international normalised ratio (INR) is performed monthly.
- Patients self managing their warfarin therapy do adhere to current UK clinical guidelines for PSM and are regularly reviewed by a clinical supervisor.
- Quality control and assurance procedures for PSM are not being performed as recommended.

with their clinical supervisor and are having regular clinical review. Concerns remain over the quality of clinical supervision and performance of quality control procedures.

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